Test of the Iris Hypothesis
Using CERES SSF Data

Lin Chambers and Bing Lin
NASA Langley Research Center
Hampton, VA 23681
Outline

1. Background
   Lindzen et al.’ (2001) climate feedback: observation & model

2. CERES Data

3. 3.5-box Model Calculation

4. Discussions: cirrus

5. Summary
Atmospheric Moisturization
Fig. 5. Scatterplots showing how cirrus coverage varies with cloud-weighted SST for both "all" (a) upper-level clouds and (b) thick clouds. Also shown is (c) the variation of cumulus area with cloud-weighted SST and (d) the variation of cirrus coverage normalized by cumulus coverage. Data points correspond to daily averages. (See text for details.)
Tst = Ts + 10K

Tset = Ts – 10K
1. Background (cont.)

Based on the anvil variations with SST observed from GMS data and 3.5-box greenhouse model, Lindzen et al. (2001) proposed a very strong negative radiative feedback of the clouds on climate change (−0.45 ~ −1.1K/K; or IR Iris).
1. Background (cont.): main points

Q: Do CERES data show the similar cloud change with SST, and feedback processes? (Since we do not know where many values in Lindzen et al. come from)
2. CERES TRMM Data

Definitions of clouds & climate regimes:
convective clouds: Tb(10.8) < 220K
cloudy moist: Tb(10.8) < 260K (anvil+DCC)
or other cloudy definitions
dry area: broadband LW↑ > LW50
LW50: 50% percentile of 8-month LW↑ statistics
## CERES Estimates

<table>
<thead>
<tr>
<th>clear moist: all other pixels</th>
<th>LaRC—CERES</th>
<th>Lindzen et al.</th>
</tr>
</thead>
<tbody>
<tr>
<td>dry</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>clear moist</td>
<td>0.4</td>
<td>0.28</td>
</tr>
<tr>
<td>cloudy moist</td>
<td>0.1</td>
<td>0.22</td>
</tr>
<tr>
<td>↓</td>
<td>338.7</td>
<td>315.9</td>
</tr>
<tr>
<td>↑</td>
<td>287.7</td>
<td>303.1</td>
</tr>
</tbody>
</table>

Note: The table contains estimates for clear moist, cloudy moist, and dry conditions, comparing LaRC—CERES and Lindzen et al. results.
Trapping 99 more
Absorbing 101 less
Net -2w/m^2
Lindzen et al. (sketch)

Trapping 125 more
Absorbing 55 less

303

263

316
Model cloud feedbacks

Solid lines: CERES; Dashed lines: Lindzen et al.
4. Discussions

LCH points:

1. Edge effects: increasing SST & keeping a constant Tb threshold (260K) ⇒ cutting out radiative warming thin cirrus

2. ‘LCH specified subjectively the ORL and albedo for the three regions while requiring that the mean OLR and albedo of the tropics are consistent with the ERBE inferred values’.
Discussions (cont.)

3. ‘LCH inferred areal coverage of high-level clouds using a threshold temperature of 260K...... This areal coverage of high-level clouds is merely an index for ......It is not meant to be the total areal coverage of high-level clouds......’

4. ‘If we assume that their estimates of OLR in the three tropical regions are appropriate for studying the climate sensitivity, the feedback factors of high-level clouds should remain negative as suggested by LCH although the magnitudes are somewhat smaller, ........’
CERES Albedo and LW
High cloud radiative forcing = -1 W/m²

Fu et al. 2001
Tb threshold versus CC

Chou et al. 2002
Effects of Tb threshold

(a) Surface Temp (K) vs. Tropical Cloudy Moist for γ=0

(b) Albedo vs. Tropical Cloudy Moist for different Tb thresholds

(c) Net Forcing (W/m²) vs. Tropical Cloudy Moist for different Tb thresholds
Effects of ice cloud amount
LW & alb vs high clouds

Tropical Ocean

LW Flux

SW Albedo

Lindzen
$T_b < 260 K$
$T_0$ Defns
Phase Defns

Cloudy Moist Fraction
Summary

1. Based on observations, eliminating cirrus clouds in the edge of extent anvil clouds will not change the net radiative forcing much (within ~2W/m$^2$).

2. Although change Tb threshold for cloudy-moist regions leads to different areal coverage and albedo of the clouds, the radiative feedback of the clouds is still small due to corresponding change in longwave radiation.

3. For all kinds of cirrus clouds (or cloudy-moist regions) we tested, the feedback factors of high-level clouds are only ~1/10 of LCH.
Acknowledgement

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